

STYLET-FREE EPIDURAL CATHETER  
AND THREAD ASSIST DEVICE

CROSS-REFERENCE TO RELATED APPLICATION

This is a divisional of U.S. Patent Application No. 09/703,892,  
5 filed November 1, 2000.

BACKGROUND OF THE INVENTION

The present invention relates to a stylet-free epidural catheter for  
insertion into a patient via a needle, as well as a thread assist device, both to  
reduce buckling of a catheter in and around the needle hub, and more  
10 particularly to a combination of such an epidural catheter and such a thread  
assist device.

Commonly assigned U.S. Patent No. 5,947,940 entitled "Catheter  
Reinforced to Prevent Luminal Collapse and Tensile Failure Thereof" is  
incorporated herein by reference. This patent discusses in detail the problems  
15 associated with medical catheters, and in particular an epidural catheter, and  
the need for reinforcement thereof to meet the rigorous requirements of an  
epidural catheter. The reinforcement disclosed is at least one helical reinforcing  
member (preferably predominantly non-metallic) wound around the  
longitudinal axis of the elongated tubular body of the catheter for reinforcing  
20 the body to prevent radial collapse thereof during bending and pinching thereof  
and to prevent longitudinal breakage thereof under tension. Such catheters  
have proven to be quite satisfactory in use and, in particular, as epidural  
catheters.

Nonetheless, the design of the catheter described above has  
25 proven to be less than totally satisfactory. Typically, the use of a stylet within  
the catheter is still required during the insertion operation. From the point of  
view of the catheter manufacturer, this results in additional costs, both for the  
manufacture of the stylet and for the insertion of the stylet through the catheter.  
From the point of view of the catheter user, an additional step in the procedure

is required to ultimately withdraw the stylet from the catheter after the stylet has served its function of stiffening the catheter sufficiently to allow it to enter the epidural space (the *ligamentum flavum*). Due to the length of the stylet, this is a time-consuming and laborious operation step. Furthermore, the removed  
5 stylet is a contaminated “sharp” which must be safely and specially disposed of in order to not expose room personnel to additional risks of contamination.

The prior art also teaches thread assist devices (TADs) which enter into the luer hub of the needle and preclude buckling (non-axial or lateral collapse) of the catheter just as the catheter distal tip is emerging from the distal  
10 end of the needle into the epidural space, a time when buckling tends to occur due to the additional resistance exerted by the ligaments of the epidural cavity. The known TADs preclude buckling of the catheter in the region of the needle hub by completely surrounding the catheter sidewall so that there is no room in which the catheter can buckle. On the other hand, this positioning of the TAD  
15 requires a practitioner to move the catheter forwardly through the needle from a point of contact (between the practitioner and the catheter) which is disposed proximally of the needle hub; this makes it more difficult for the surgeon to introduce a substantially straight or linear length of the catheter into the needle hub. At the very time that the practitioner is pressing on the catheter with his  
20 fingers and using friction (between his fingers and the catheter) to slide the catheter forwardly through the TAD and the needle, there is a tendency for the practitioner to laterally deflect the catheter before it enters the TAD so that it is no longer in axial alignment with the needle and the TAD. Thus, the need remains for a TAD for use with an epidural catheter (whether reinforced or not)  
25 which enables movement of the catheter slidingly along the needle without deflecting the catheter from the needle axis.

Accordingly, it is an object of the present invention to provide a catheter which does not require a stylet for the insertion operation.

Another object is to provide such a catheter which is economical  
30 to produce.

A further object is to provide a thread assist device (TAD) to facilitate passage of a catheter through a needle.

### SUMMARY OF THE INVENTION

In one aspect, the present invention relates to a stylet-free catheter  
5 for insertion into a patient via a needle, wherein the needle defines proximally a  
needle hub and distally a needle tip. The catheter comprises a proximal end, a  
distal end, and a body connecting the proximal and distal ends. The body  
defines therealong a stiffening section of a predetermined length disposed a  
predetermined distance proximally of the distal end such that it is located  
10 generally about an area where the body approaches the needle hub when the  
distal end approaches the needle tip. The stiffening section has a flexural  
stiffness at least twice that of the remainder of the body.

In a preferred embodiment, the stiffening section has a length of  
about 5 (preferably 7) cm, disposed from about 10 cm to about 15 cm  
15 proximally of the distal end, and has a diameter not exceeding the diameter of  
the remainder of the body by more than about 0.15 mm.

In one preferred embodiment, the stiffening section is formed of  
plastic tubing and a cured adhesive extending circumferentially about the plastic  
tubing to provide a stiffening coating. The cured adhesive preferably is UV-  
20 cured *in situ*. In an alternatively preferred embodiment, the stiffening section is  
formed of plastic tubing and a plastic sleeve heat-shrunk about the plastic  
tubing to stiffen the plastic tubing. The sleeve is preferably polyethylene  
terephthalate (PET). In both preferred embodiments, the stiffening  
coating/sleeve is non-tacky and wear-resistant, has a thickness not exceeding  
25 about 0.08 mm, extends in a substantially uniform thickness along the stiffening  
section and about the plastic tubing, and reinforces the plastic tubing of the  
stiffening section.

The present invention also encompasses in combination such a  
catheter and a needle defining proximally a needle hub and distally a needle tip.

The present invention further encompasses a thread assist device to reduce buckling of a catheter being inserted through a needle. The TAD comprises a body defining a proximal end, a distal end substantially spaced along a longitudinal axis from the proximal end, and a sidewall connecting the proximal and distal ends. The TAD distal end is configured and dimensioned for at least partial receipt and releasable maintenance within a hub of a needle, and the TAD sidewall is configured and dimensioned to enable axial sliding manipulation of a catheter through the needle hub and through the needle by a user. The TAD proximal and distal ends substantially preclude non-axial or lateral movement of the catheter at the TAD ends, and the TAD sidewall limits non-axial or lateral movement of the catheter between the TAD ends. In a preferred embodiment, the TAD sidewall is generally cylindrical but extends no more than 180° about the TAD body intermediate the TAD proximal and distal ends to define a gap intermediate its long edges such that a user can establish axial sliding manipulation of the catheter through the gap and further limit non-axial movement of the catheter between the TAD ends.

In another embodiment, the TAD sidewall extends over an arc of no more than about 90° about the TAD body intermediate the TAD ends and is slightly bowed outwardly from the TAD longitudinal axis for substantially the entire length of the TAD sidewall along the catheter, thereby to increase the potential extent of contact between the user and the catheter between the TAD ends and thus facilitate grasping and generally axial movement of the catheter through the TAD by the user.

The present invention also encompasses in combination such thread assist device, a catheter, and a needle, the distal end of the TAD being at least partially disposed in the hub of the needle, and the catheter extending through the TAD proximal end, along the TAD sidewall, through the TAD distal end and into the needle.

Further, the present invention specifically encompasses the combination of such a catheter and such a TAD.

BRIEF DESCRIPTION OF THE DRAWING

The above and related objects, features, and advantages of the present invention will be more fully understood by reference to the following detailed description of the presently preferred, albeit illustrative, embodiments of the present invention when taken in conjunction with the accompanying drawing wherein:

FIG. 1 is a fragmentary exploded side elevational view of a stylet-free epidural catheter according to the present invention;

FIG. 2 is a sectional view thereof taken along the line 2-2 of FIG. 1;

FIG. 3 is a fragmentary assembly side elevational view of the catheter rotated 90° about its axis from FIG. 1;

FIG. 4 is a sectional view thereof taken along the line 4-4 of FIG. 3;

FIG. 5 is a sectional view thereof taken along the line 5-5 of FIG. 4;

FIG. 6 is a sectional view taken along the line 6-6 of FIG. 5;

FIG. 7 is a fragmentary exploded side elevational view of a thread assist device according to the present invention;

FIG. 8 is a sectional view taken along the line 8-8 of FIG. 7;

FIG. 9 is a fragmentary assembly side elevational view of the TAD rotated 90° about its axis from FIG. 7;

FIG. 10 is a sectional view thereof taken along the line 10-10 of FIG. 9;

FIG. 11 is a sectional view thereof taken along the line 11-11 of FIG. 10;

FIG. 12 is a view similar to FIG. 10, but of another embodiment of the TAD; and

FIG. 13 is a sectional view thereof taken along the line 13-13 of FIG. 12.

### DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now to the drawing, and in particular FIGS. 1-6 thereof, therein illustrated is a stylet-free epidural catheter according to the present invention, generally designated by the reference numeral 10. The catheter 10 is  
5 designed for insertion into a patient via a needle, generally designated 12, defining proximally a needle hub 14, distally a needle tip 16 and optionally a pair of wings 17 .

In its conventional aspects, the catheter 10 includes a proximal end 22, a distal end 24 and a body section, generally designated 26, connecting  
10 the proximal and distal ends 22, 24.

In its novel aspects, the body 26 of catheter 10 defines therealong a stiffening section, generally designated 30. The stiffening section 30 is of a predetermined length (preferably about 5 cm) and is disposed a predetermined distance proximally of the distal end 24 (preferably from about 10 cm to about  
15 15 cm proximally of the distal end) such that it is located generally about an area where the catheter body 26 approaches the needle hub 14 when the catheter distal end 24 approaches the needle tip 16. This is a critical point in the functioning of the epidural device because, as the catheter distal end 24 begins to emerge from the distal needle tip 16, it encounters resistance which  
20 must be overcome by the surgeon sliding the catheter 10 through the needle 12. The stiffening section 30 has a diameter not exceeding the diameter of the remainder of the body 26 by more than about 0.15 mm so that the increase in thickness at the stiffening section 30 is barely appreciable. As will be apparent to those skilled in the art, the length and positioning of the stiffening section 30  
25 may be adjusted for use in various epidural needles (for example, needles for different species), with the object always being that the strengthening section will be entering the needle hub as the catheter distal end is emerging from the needle tip.

It is a critical factor of the present invention that the stiffening  
30 section 30 has a flexural strength (that is, it resists non-axial or lateral bending)

which is at least twice the flexural strength of the remainder of the catheter body 26. Flexural strength is easily measured using an Instron Tester. A minimum doubling of the flexural strength of the stiffening section (relative to the plastic tubing 32 alone of the remainder of the catheter body 26) obviates the need to employ a stylet in order to stiffen the catheter. Nonetheless, the stiffness of the stiffening section 30 must not preclude such bending thereof as may be necessary for it to pass through the curved needle tip 16. (Most needle tips are curved to facilitate passage therethrough of the catheter.) Further, the stiffening section 30 must not be so thick that it cannot pass through the needle 12 (and especially the needle tip 16).

The stiffening section 30 may be formed by various mechanisms.

In a first preferred mechanism illustrated in FIG. 1, the stiffening section 30 is formed of plastic tubing 32 (similar to the plastic tubing of the remainder of the catheter body 26) and a cured adhesive 34 extending circumferentially about the plastic tubing 32 to provide a stiffening coating 36. Preferably the stiffening coating 36 is non-tacky and is wear-resistant. The stiffening coating 36 preferably has a thickness not exceeding about 0.08 mm. Ideally, the stiffening coating 36 extends in a substantially uniform thickness along the stiffening section 30 and about the plastic tubing 32, so that it reinforces the plastic tubing 32 of the stiffening section 30. The cured adhesive is preferably a UV (ultraviolet) - cured adhesive tolerated by the patient's body, and optimally it is cured *in situ*. In other words, the uncured adhesive is applied about the plastic tubing 32 of the stiffening section 30 and then cured in place using ultraviolet light.

In a second preferred mechanism also illustrated in FIG. 1, the stiffening section 30 is formed of plastic tubing 32 (similar to the plastic tubing of the remainder of the catheter body 26) and a plastic sleeve 44 heat-shrunk about the plastic tubing 32 to provide a stiffening sleeve 46. As in the case of the stiffening coating 36, the stiffening sleeve 46 is preferably non-tacky and wear-resistant, has a thickness not exceeding 0.08 mm and ideally extends in a

substantially uniform thickness along the stiffening section 30 and about the plastic tubing 32 so that the stiffening sleeve 46 reinforces the plastic tubing 32 of the stiffening section 30. The sleeve 44 may be made of any suitable heat-shrinkable plastic which is tolerated by the patient's body and provides the  
5 desired stiffening action when heat shrunk. A preferred plastic is polyethylene terephthalate (PET).

A conventional thread assist device (TAD) 48 has a front end which is inserted into the needle hub 14 and a rear end which is entered by the catheter front end 24, a length of the catheter body 26, the stiffening section 30  
10 and more of the length of the catheter body 26.

Referring now to FIGS. 7-11 in particular, therein illustrated is a thread assist device (TAD) according to the present invention, generally designated by the reference numeral 50, to reduce buckling (i.e., lateral or non-axial collapse) of a catheter being inserted through a needle 12, regardless of  
15 whether that catheter is a catheter 10 according to the present invention (as described hereinabove) or a conventional catheter. As the TAD 50 and stiffening section 30 serve the same function (that is, to reduce buckling of the catheter being inserted through the needle), typically the thread assist device finds greatest utility in use with a conventional catheter rather than a catheter  
20 10 according to the present invention (as the latter typically does not require a TAD to be used).

The TAD 50 comprises a body, generally designated 52, defining a proximal end 54, a distal end 56, and a sidewall 60 connecting the TAD proximal and distal ends 54, 56. The TAD proximal and distal ends 54, 56 are  
25 substantially spaced apart along a longitudinal axis of the TAD body 52 and define respective full cylinder passageways 55, 57 therethrough, respectively. The distal end 56 of the TAD body 52 is configured and dimensioned for at least partial receipt and releasable maintenance within a needle hub 14.

The TAD sidewall 60 is configured and dimensioned intermediate  
30 the TAD proximal and distal ends 54, 56 to enable axial sliding manipulation of



the catheter through the needle hub 14 by a user. More particularly, the sidewall 60 is generally cylindrical, but (as best seen in FIGS. 10 and 11) extends only about  $180^\circ$  (and clearly no more than  $270^\circ$ ) about the TAD body 52 intermediate the TAD proximal and distal ends 54, 56 thereof. Thus the TAD sidewall 60 defines a gap 62 intermediate the long edges of the sidewall 60 subtending an angle of about  $180^\circ$  (and optionally less). This gap 62 is configured and dimensioned to enable a user to establish axial sliding manipulation of the catheter by inserting one or more fingers (or fingertips) through the gap 62 and against the catheter, thereby pressing the catheter against the TAD sidewall 60. The TAD proximal and distal ends 54, 56 substantially preclude non-axial movement of the catheter at the TAD ends, as such TAD ends extend fully about the circumference of the catheter portions extending therethrough. Because the pressure of the user's finger on the catheter only presses the catheter against the sidewall 60, the finger pressure further limits non-axial movement (buckling) of the catheter between the TAD ends 54, 56. The absence of any deflection of the catheter as it is being manipulated through the needle 12 facilitates the manipulation process by ensuring a common alignment of the longitudinal axes of the needle 12 and the catheter body 26.

Referring now to FIGS. 12 and 13, therein illustrated is a variant, generally designated 50', of the preferred TAD embodiment illustrated in FIGS. 7-11. The variant 50' is similar to the embodiment 50, except that in the variant 50' the TAD sidewall 60' defines a gap 62' subtending an angle of about  $90^\circ$  (and optionally less)– i.e., the sidewall 60' extends circumferentially about the catheter over an arc of no more than about  $90^\circ$  about the TAD body 52 intermediate the TAD ends 54, 56. Furthermore, in the variant 50', the TAD sidewall 60' is slightly bowed outwardly from the TAD longitudinal axis for substantially the entire length of the TAD sidewall 60' along the catheter. While the TAD proximal and distal ends 54, 56 still preclude buckling of the catheter therein, the lesser arc of the TAD sidewall 60' and the spacing of the TAD

sidewall 60' from the unstressed catheter increases the potential extent of contact between one or more of the user's fingers and the catheter between the TAD ends 54, 56 as more of the catheter circumference is exposed and engageable by the user's fingertips. Accordingly, grasping and generally axial  
5 movement of the catheter through the variant TAD 50' by the user is facilitated.

The TAD is preferably formed of a plastic, such as a medical grade thermoplastic material, which preferably exhibits a low flexural modulus in order to allow the TAD to be bent by the practitioner's finger during the placement operation. A preferred material is a low-density polyethylene.

10 While the drawing illustrates the reinforced epidural catheter 10 in combination with a TAD 50, it will be appreciated that the TAD 50 may be used with catheters other than the catheter 10 of the present invention.

To summarize, the present invention provides a stylet-free catheter which is economical to produce. The present invention further  
15 provides a thread assist device (TAD) to facilitate passage of a catheter (whether reinforced or not) through a needle.

Now that the preferred embodiments of the present invention have been shown and described in detail, various modifications and improvements thereon will become readily apparent to those skilled in the art.  
20 Accordingly, the spirit and scope of the present invention is to be construed broadly and limited only by the appended claims, and not by the foregoing specification.